

RC24xx/RC24xxHP Firmware Development User Manual

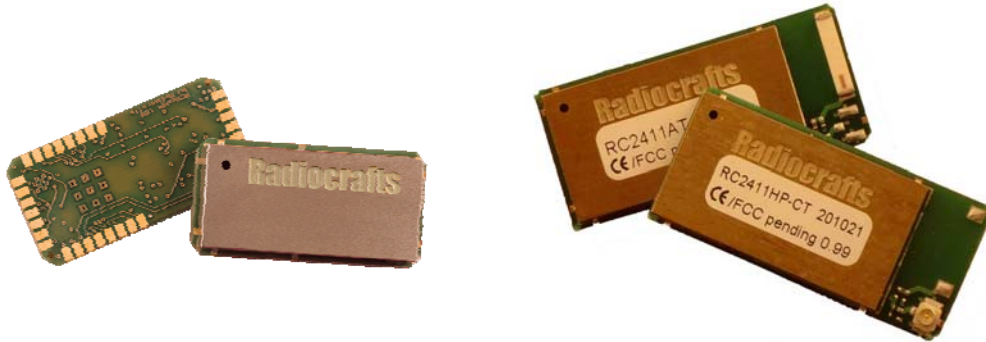


Table of contents

TABLE OF CONTENTS	1
INTRODUCTION	2
DOCUMENTATION STRUCTURE	2
QUICK PRODUCT INTRODUCTION.....	2
PIN ASSIGNMENT RC2400/RC2400HP	3
PIN DESCRIPTION RC2400/RC2400HP	3
PIN ASSIGNMENT RC2410/RC2410HP	4
PIN DESCRIPTION RC2410/RC2410HP	4
BLOCK DIAGRAM.....	6
EMBEDDED RESOURCES	6
CIRCUIT DESCRIPTION	6
I/O RESOURCES	7
IEEE 802.15.4.....	8
THE ZIGBEE PROTOCOL.....	8
ZIGBEE IMPLEMENTATION: DEVELOPING WITH Z-STACK.....	9
MODIFICATION OF Z-STACK FOR RC24XX/RC24XXHP (Z-STACK REV 2.3.0).....	9
PACKET SNIFFER.....	9
6LOWPAN.....	10
DOCUMENT REVISION HISTORY	11
DISCLAIMER	11
TRADEMARKS	11
LIFE SUPPORT POLICY	11
CONTACT INFORMATION.....	11

Introduction

This document with references includes all required information to develop a customer-specific firmware solution on the RC24xx/RC24xxHP hardware platforms.

Documentation structure

This document is one part of the documentation for the module. The data sheet describes the electrical parameters, RF performance, footprint and PCB layout and regulatory information. Depending on the selected FW solution, additional User Manuals should be used. The available documents for the RC24xx product series are:

- RC2400/RC2400HP Data sheet
- RC241x/RC241xHP Data sheet
- RC24xx/RC24xxHP Firmware Development User Manual (this document)
- RC24xx/RC24xxHP-ZNM User Manual - Details on how to use the ZNM (ZigBee(R) Network Management) module with preloaded ZigBee Pro stack and API through serial interface.

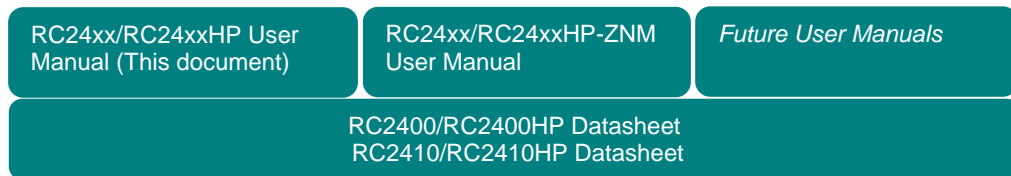


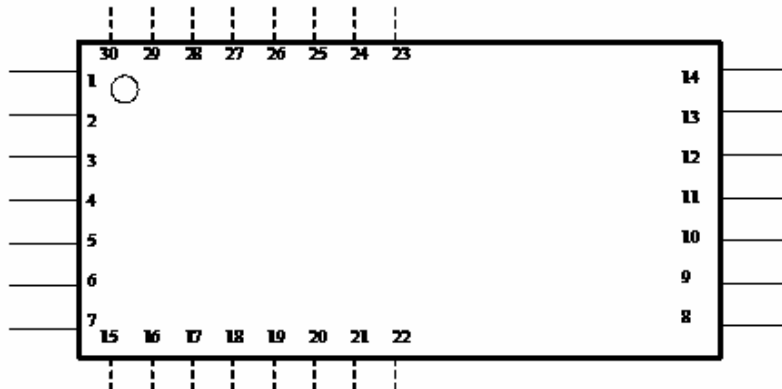
Figure 1 Document structure

Quick Product Introduction

The RC24xx series of modules are compliant with the IEEE 802.15.4 standard used by ZigBee PRO, 6LoWPAN and a number of other standards operating on IEEE 802.15.4. The module together with the TI Z-stack or any other ZigBee network implementation is a powerful combination for any ZigBee profile and application. The module contains qualified RF hardware and enough processor power to run the complete ZigBee mesh network protocol for a full function device including the application.

Using a pre-qualified module is the fastest way to make a ZigBee product with shortest time to market. With all the RF HW and MCU resources you need in a 100% RF tested and pre-qualified module the qualification and approval process is shortest possible. No RF design or expertise is required to add powerful wireless networking to any product. In the simplest case like a home light remote control you only need an external battery and a pushbutton.

Pin Assignment RC2400/RC2400HP

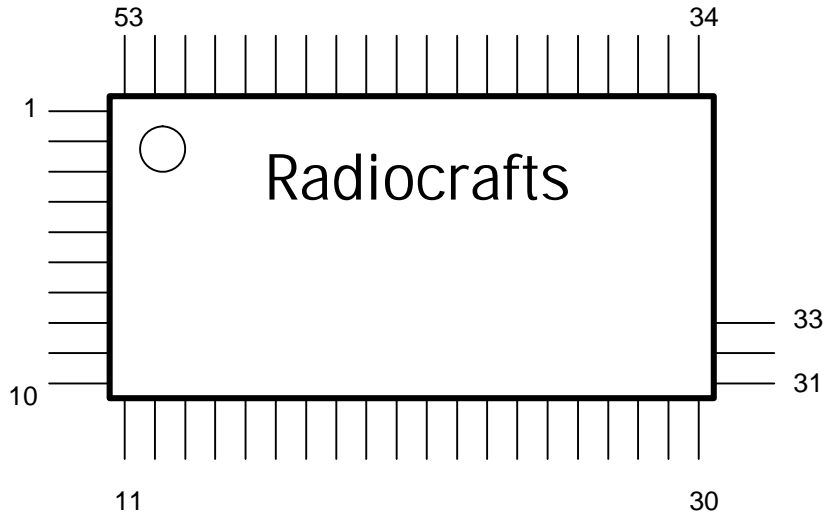


Pin Description RC2400/RC2400HP

Pin no	Pin name	Description
1	GND	System ground
2	CTS/P0_4	CC2530 P0 [4]
3	RTS/P0_5/	CC2530 P0 [5]
4	P0_1	CC2530 P0 [1]
5	TXD/P0_3	CC2530 P0 [3]
6	RXD/P0_2	CC2530 P0 [2]
7	GND	System ground
8	GND	System ground
9	RF	RF I/O connection to antenna
10	GND	System ground
11	NC	Not Connected
12	RESET	CC2530 RESET_N. Active Low
13	VCC	Supply voltage input. Internally regulated.
14	GND	System ground
15	P0_7	CC2530 P0 [7]/HGM for RC2400HP
16	P1_2	CC2530 P1 [2]
17	P0_6	CC2530 P0 [6]
18	P2_0	CC2530 P2 [0]
19	P2_1/DD	Debug Data P2 [1]. Debug interface is used for programming.
20	P2_2/DC	Debug Clock P2 [2]. Debug interface is used for programming.
21	P0_0	CC2530 P0 [0]
22	P1_3	CC2530 P1 [3] /EN for RC2400HP
23	P2_4/32kHz_Q1	Internal 32 kHz crystal oscillator. Do not connect. (P2.4 if no crystal)
24	P2_3/32kHz_Q2	Internal 32 kHz crystal oscillator. Do not connect. (P2.3 if no crystal)
25	P1_7	CC2530 P1 [7]/GIO/UART RX
26	P1_6	CC2530 P1 [6]/GIO/UART TX
27	P1_5	CC2530 P1 [5]/GIO/UART RTS
28	P1_4	CC2530 P1 [4]/GIO/UART CTS
29	P1_1	CC2530 P1 [1] with optional ADC input. LED driver/PA_EN for RC2400HP
30	P1_0	CC2530 P1 [0] with optional ADC input. LED Driver

Note 3: Pins 17 and 18 are suggested as I2C interface. They can be configured otherwise, but are connected to an internal EEPROM with I2C address = 000. It is recommended to leave these pins as I2C. Sensors and actuators or any other I2C device can be connected to these pins and accessed from the module.

Pin Assignment RC241x/RC241xHP

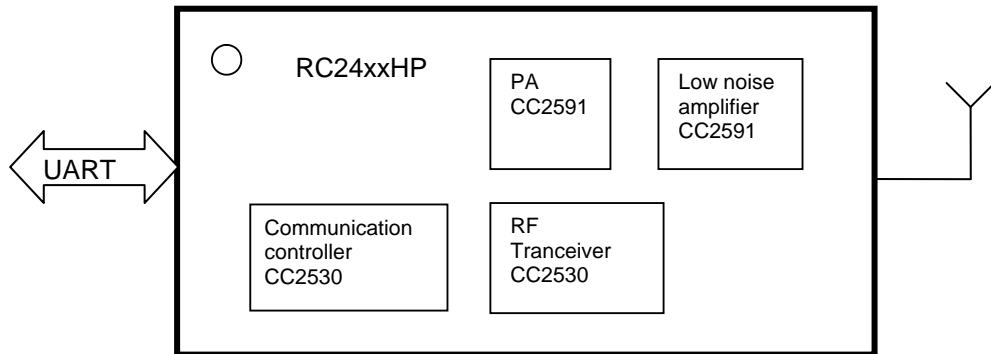


Pin Description RC241x/RC241xHP

Pin no	Pin name	Description and internal MCU connection
1	GND	System ground
2	NC	Reserved for optional USB_M on CC2531
3	NC	Reserved for optional USB_P on CC2531
4	GND	System ground
5	P0_4	CC2530, P0_4
6	P0_5	CC2530, P0_5
7	P0_1	CC2530, P0_1
8	P0_3	CC2530, P0_3
9	P0_2	CC2530, P0_2
10	GND	System ground
11	GND	System ground
12	P0_7	CC2530, P0_7, HGM for PA CTRL IN HP VERSION
13	P1_2	CC2530, P1_2, Chip select for SPI FLASH
14	P0_6	CC2530, P0_6, Connected to EEPROM if mounted
15	P0_0	CC2530, P0_0
16	P1_3	CC2530, P1_3 ENABLE(LNA_ENABLE) FOR PA CTRL IN HP VERSION
17	RESET_N	RESET for CC2530
18	NC	Not connected
19	NC	Not connected
20	NC	Not connected
21	NC	Not connected
22	NC	Not connected
23	NC	Not connected
24	NC	Not connected
25	NC	Not connected
26	NC	Not connected
27	NC	Not connected
28	NC	Not connected
29	NC	Not connected
30	GND	System ground

31	GND	System ground
32	RF_TEST	RF I/O connection for Automatic test purposes. - For components intended for use with UFL connector, do not connect this pad.
33	GND	System ground
34	GND	System ground
35	VCC	VCC
36	NC	Not connected
37	NC	Not connected
38	NC	Not connected
39	NC	Not connected
40	NC	Not connected
41	SPI_FLASH_RESET	RESET for SPI flash, NC for without SPI flash
42	P2_4	CC2530, P2_4, Connected to 32kHz crystal
43	P2_3	CC2530, P2_3, Connected to 32kHz crystal
44	P2_2	CC2530, P2_2/DC
45	P2_1	CC2530, P2_1/DD
46	P2_0	CC2530, P2_0, Connected to EEPROM if mounted
47	P1_7	CC2530, P1_7, Connected to SPI flash
48	P1_6	CC2530, P1_6, Connected to SPI flash
49	P1_5	CC2530, P1_5, Connected to SPI flash
50	P1_4	CC2530, P1_4
51	P1_1	CC2530, P1_1, PA ENABLE FOR PA CTRL IN HP VERSION
52	P1_0	CC2530, P1_0
53	GND	System ground

Block Diagram



Embedded resources

MCU: Enhanced single-cycle 8051 with 256 kB Flash
PHY/MAC: Texas Instruments (TI) CC2530, and CC2591 for RC24xxHP
Connection between CC2530 and CC2591 are as follows.

CC2530	CC2591
P1_1	PA_EN
P1_3	EN
P0_7	HGM

Firmware: Not included, but ZigBee and IEEE 802.15.4 firmware can be downloaded for free from www.ti.com.
For 6LoWPAN stack please contact sales@radiocrafts.com.

For module with preloaded ZigBee stack see RC24xx-ZNM, ZigBee Network Module.

Circuit Description

The module contains an IEEE 802.15.4 compliant SoC RF transceiver, internal EEPROM (optional), high speed oscillator and an RTC 32 kHz oscillator.

The module includes two USART that are configurable as either SPI or UART. Totally 19 I/O pins are available to the user. 8 pins can be used for the internal 8-12 bit A/D converter. All of the pins have interrupt features.

The MCU provides several low power modes with can be utilized to reduce the current consumption in battery operated applications. An optional internal 32 kHz crystal oscillator can be used for real-time clock and timer applications.

The module has an internal POR circuit and a brown out detector, but it is still highly recommended to add an external power supervisory circuit to ensure a proper reset when a power fault has occurred.

For further details on the SoC transceiver (TI CC2530 and CC2591), please consult the respective data sheet.

I/O resources

The module has 19 digital I/O pins, but in case of -HP or with the inclusion of RTC the pin number available for application is slightly lower. They are shown in the table below together with the additional I/O feature associated with them. When using -HP modules the pins P1_1, P1_3 and P0_7 must be left unconnected.

PIN	RC241x/RC241xHP	RC2400/RC2400HP	Port/ Function	P0_4	P0_5	P0_1	P0_3	P0_2	P0_7	P1_2	P0_6	P2_0	P2_1	P2_2	P0_0	P1_3	P2_4	P2_3	P1_7	P1_6	P1_5	P1_4	P1_1	P1_0
52		30																						
51		29																						
50		28																						
49		27																						
48		26																						
47		25																						
43		24																						
42		23																						
16		22																						
15		21																						
44		20																						
45		19																						
46		18																						
14		17																						
13		16																						
12		15																						
9		6																						
8		5																						
7		4																						
6		3																						
5		2																						
	ADC			X	X	X	X	X	X															
	USART0 SPI																							
	AiI2																							
	USART0 UART																							
	AiI2																							
	USART1 SPI																							
	AiI2																							
	USART1 UART																							
	AiI2																							
	Timer1																							
	AiI2																							
	Timer3																							
	AiI2																							
	Timer4																							
	AiI2																							
	32 kHz XOSC																							
	DEBUG																							
	CC2591 CTRL.in RC2400HP /RC241xHP																							

IEEE 802.15.4

The IEEE 802.15.4 standard provides a worldwide standard for Personal Area Networks and short distance wireless networks for low data rate solutions with long battery life and low complexity. The standard defines a Physical layer (PHY) and a Medium Access Control layer (MAC). There are two active versions of the standard: IEEE 802.15.4-2003 and IEEE 802.15.4-2006 where the 2003 version is a basis for the ZigBee protocol. The typical applications are meter reading, home and building automation, industrial control and monitoring systems, wireless sensor networks, remote controls and consumer electronics.

The module complies with the IEEE 802.15.4 standard operating in the 2.45 GHz band. It uses direct sequence spread spectrum (DSSS) with 2 Mc/s chip rate giving a raw data rate of 250 kbit/s. 16 channels are available in the 2.45 GHz band named channel 11 – 26 (channels 0-10 are reserved for use in the 868 and 915 MHz bands).

For more information on the standard, please consult www.ieee802.org/15/pub/TG4.html

The ZigBee Protocol

The ZigBee Alliance is an association of companies working together to enable reliable, cost-effective, low-power, wirelessly networked, monitoring and control products based on an open global standard. The ZigBee Alliance is a rapidly growing, non-profit industry consortium of leading semiconductor manufacturers, technology providers, OEMs and end-users worldwide. Membership is open to all. The ZigBee Alliance, in collaboration with the IEEE, is defining the network, security, and application layers above the IEEE 802.15.4 PHY and MAC layers. This cooperation has resulted in an easy-to-use, industry standard wireless network platform optimised for wireless monitoring and control applications.

The ZigBee standard defines a Network Layer and an Application Layer on top of IEEE 802.15.4. The network layer includes routing, security etc. while the application layer defines binding and other support for application.

The applications are specified in profiles to ensure multi-vendor interoperability. Current public profile includes:

- Smart Energy - SE (Profile for Smart Meter reading)
- Building Automation - CBA
- Home Automation - HA
- Health Care - HC
- Telecom Services - TA
- Remote Control - RF4CE

Manufacturer specific profiles can also be made.

The current version of the ZigBee standard is 2007. The standard defines two different stack feature sets:

- ZigBee Feature set
- ZigBee PRO feature set

In order to sell a product containing ZigBee technology, the seller must be a member (adaptor or higher) of the ZigBee alliance.

For more information about the ZigBee Alliance and the ZigBee standard, please consult www.zigbee.org.

ZigBee implementation: Developing with Z-stack

Z-stack™ from Texas Instruments is a free ZigBee PRO compliant stack for RC24xx/RC24xxHP. See www.ti.com/z-stack for stack download and full documentation package.

The stack is supported for IAR EW8051. For info on revisions supported see z-stack documentation. See www.iar.com for trial versions and licences.

The Z-stack also includes example application for general applications and examples for Smart Energy (SE) devices.

For debugging and programming a module the CC-debugger from TI is recommended. It is included in the demo kit and can also be bought online here:

<http://focus.ti.com/docs/toolsw/folders/print/cc-debugger.html>

Modification of Z-stack for RC24xx/RC24xxHP (Z-stack rev 2.3.0)

For RC24xx the z-stack 2.3.0 can be used without modification.

For RC24xxHP the compile directive for `HAL_PA_LNA` must be activated. This can be done in `hal_board_cfg.h` line 64.

In addition one control signal for CC2591 control must be moved from pin P1_4 to P1_3. This is done by modifying `OBSSEL4` to `OBSSEL3` in `mac_radio_defs.c`

In addition the register `MDMTEST0` must be altered for optimum performance at high output power levels. This is by inserting `MDMTEST0 |= 0x80;` in `mac_mcu.h` line 186

For successful compilation of the code

```
uint8 OSC_32KHZ = ((P1_2) ? 0x00 : 0x80); \
```

must be inserted in `hal_board_cfg.h` line 320

Packet sniffer

For evaluating and testing an application on network level a packet sniffer is a useful tool. We recommend using the following combination:

- Texas Instruments Packet Sniffer (PC tool)

P.nbr.	Time (us)	Length	Frame control field	Sequence number	Dest. PAN	Dest. Address		LOI	FCS
RX 5	+10890705 =55994647	10	Type Sec Pnd Ack.req PAN_compr CMD 0 0 0 0	0xEC	0x9FFF	0x9FFF	Beacon request	184	OK
RX 6	+2396 =55997043	28	Type Sec Pnd Ack.req PAN_compr BCH 0 0 0 0	0x18	0x9DEE	0x0000	Superframe specification		
RX 7	+511420 =56508463	21	Type Sec Pnd Ack.req PAN_compr CMD 0 0 1 0	0xED	0x9DEE	0x0000	Association request		
RX 8	+1056 =56509519	5	Type Sec Pnd Ack.req PAN_compr ACK 0 0 0 0	0xED				132	OK
RX 9	+495246 =57004765	18	Type Sec Pnd Ack.req PAN_compr CMD 0 0 1 1	0xEE	0x9DEE	0x0000	Data request	184	OK
RX 10	+960 =57005725	5	Type Sec Pnd Ack.req PAN_compr ACK 0 1 0 0	0xEE				132	OK
RX 11	+2398 =57008123	27	Type Sec Pnd Ack.req PAN_compr CMD 0 0 1 1	0x75	0x9DEE	0x00124B0001098094	Short addr Assoc. status	132	OK
RX 12	+1248 =57009371	5	Type Sec Pnd Ack.req PAN_compr ACK 0 0 0 0	0x75				184	OK

Figure 2 Screenshot from packet sniffer

6LoWPAN

6LoWPAN is an acronym for IPv6 over LoW power Wireless Personal Area Network and is a standard for transmitting IPv6 packets over IEEE 802.15.4 compliant radios. The standard is open and maintained by the 6LoWPAN working group with in IETF.

RC24xx/RC24xxHP is compliant with 6LoWPAN and a stack is available from third parties.

Document Revision History

Document Revision	Changes
1.0	First release
1.1	Updated with reference RC2410/RC2410HP
1.2	Corrected I/O resource table, P0_2/P0_3 swapped. Included RC241xHP in the table

Disclaimer

Radiocrafts AS believes the information contained herein is correct and accurate at the time of this printing. However, Radiocrafts AS reserves the right to make changes to this product without notice. Radiocrafts AS does not assume any responsibility for the use of the described product; neither does it convey any license under its patent rights, or the rights of others. The latest updates are available at the Radiocrafts website or by contacting Radiocrafts directly.

As far as possible, major changes of product specifications and functionality, will be stated in product specific Errata Notes published at the Radiocrafts website. Customers are encouraged to check regularly for the most recent updates on products and support tools.

Trademarks

RC232™ is a trademark of Radiocrafts AS. The RC232™ Embedded RF Protocol is used in a range of products from Radiocrafts. The protocol handles host communication, data buffering, error check, addressing and broadcasting. It supports point-to-point, point-to-multipoint and peer-to-peer network topologies.

All other trademarks, registered trademarks and product names are the sole property of their respective owners.

Life Support Policy

This Radiocrafts product is not designed for use in life support appliances, devices, or other systems where malfunction can reasonably be expected to result in significant personal injury to the user, or as a critical component in any life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness. Radiocrafts AS customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Radiocrafts AS for any damages resulting from any improper use or sale.

© 2010, Radiocrafts AS. All rights reserved.

Contact Information

Web site: www.radiocrafts.com

Email: radiocrafts@radiocrafts.com

Address:

Radiocrafts AS
Sandakerveien 64
NO-0484 OSLO
NORWAY

Tel: +47 4000 5195

Fax: +47 22 71 29 15

E-mail: sales@radiocrafts.com

support@radiocrafts.com